



Invited Article

The Contributions of Kenelm Hutchinson Digby to Orthopaedics in Hong Kong Part 2

坎奈姆·狄比教授 Professor Kenelm Hutchinson Digby 對香港骨科的貢獻(第二部)

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ABSTRACT

As the first professor of surgery in Hong Kong, Kenelm Hutchinson Digby had the tremendous task of building a new clinical department in the infant University of Hong Kong from scratch. Despite his heavy commitments in clinical, administrative, and teaching responsibilities, he pioneered novel orthopaedic treatment principles and techniques, in addition to that of general surgery.

中文摘要

坎奈姆·狄比教授作為香港的第一位外科教授，不得不負起從頭開始在一所新大學中建立一個新的臨床部門的艱鉅任務。儘管他在臨床、行政、教學的職責繁重，除了在外科的貢獻，他還開創了新的骨科治療原則和技巧。

Introduction

For over two millennia, people of the Chinese Empire thrived on their indigenous traditional medicine and bone-setting. Modern medicine in China owes its inception to Anglo-American medical missionaries arriving in the first half of the nineteenth century. Western-style medical education in Hong Kong commenced in 1887 with the founding of the Hongkong College of Medicine for Chinese. This College, staffed by part-time lecturers, was the stock onto which the University of Hong Kong was grafted in 1912. In the beginning there were only two faculties: Medicine and Engineering. Professor Digby was the one of the first two full-time University staff. In this second part, Digby's other contributions to the theory and the practice of orthopaedics in Hong Kong are presented.

Orthopaedic appliances

Digby proposed more applications of the pneumatic tourniquet in limb surgery.

Plea for the general use of pneumatic tourniquet

The usual practice of arresting haemorrhage in limbs during operations by winding tightly stretched elastic tubing has certain disadvantages. The assistant may fail to apply the tourniquet with sufficient tightness, or the tourniquet is applied so as to exert unnecessary degree of compression resulting in nerve and vessel injuries. The ordinary sphygmomanometer makes an excellent pneumatic tourniquet. It has the following advantages:

- (1) No violence can be caused by its application.
- (2) Only the minimum pressure required is employed.
- (3) The tourniquet can be inflated or released easily and instantaneously.¹

Due to the hot Hong Kong summer, Digby noted the unsuitability of rubber pneumatic tourniquet. He began to test different pressure gauges in conjunction with compression.

Preliminary note on a tourniquet meter

The need for some methods of measuring the pressure exerted on the limb by a tourniquet has long been recognized. The sphygmomanometer has two drawbacks: its bulky nature and its

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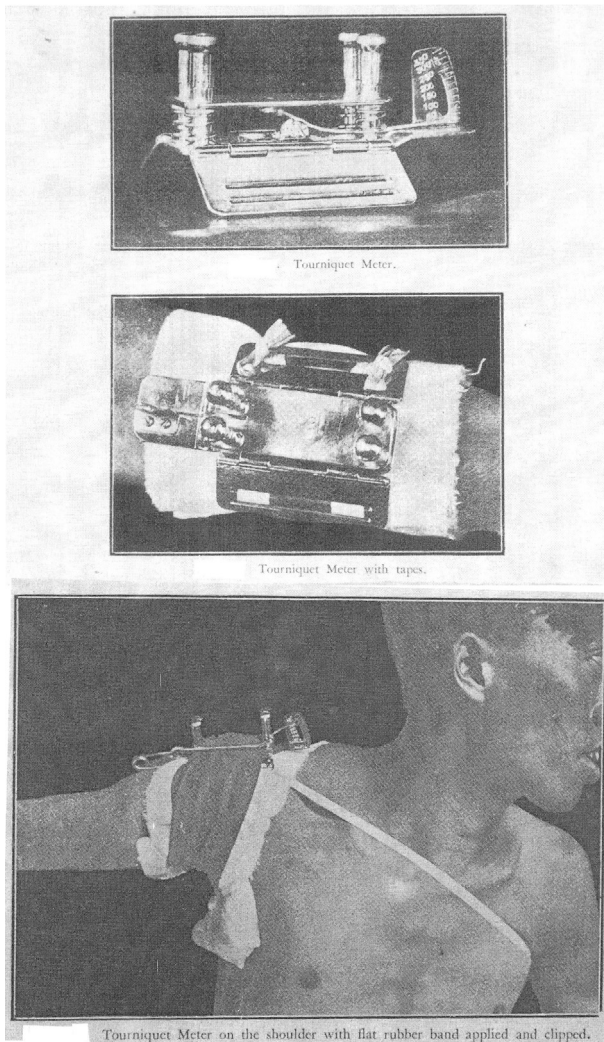


Figure 1. Tourniquet meter devised by Digby for application in limb surgery. From Digby [2]. Permission for reproduction has been applied to *The Caduceus: Journal of the Hong Kong University Medical Society*.

sterilisability. Time has been expended in this clinic in trying to provide a more suitable and equally safe tourniquet. A special narrow sterilisable pneumatic tourniquet with pressure page has been devised, but the rubber, at least in a tropical climate, does not last well, and the tourniquet is difficult to adjust to all sizes of limbs. In 1932, George Salter and Co. Ltd., West Bromwich, England, prepared a light meter to be used beneath a Martin bandage. This pattern has subsequently been modified in the light of experience by the university's Ho Tung Engineering Workshop (Figure 1). It is a practice to apply a pressure equivalent to 200 mmHg for the upper limb and 250 mmHg for the lower limb, for nearly all cases in adults. These have been safely left on for an hour, and could possibly be left on longer without harm. The meter consists of two flat plates of duralumin. To the lower plate is attached on each side a hinged flap. Each flap has two slots for the attachment of tapes. The lower plate is prolonged at one end to bear a vertical scale. Four vertical rods are attached to the lower plate through holes in the upper plate. On these rods and the plates are four metal springs, and between the plates also is situated the lever attachment from which the pointer passes to the scale. The four rods pass well above the plates and are covered by screw caps. For operations high up the limbs, the meter is applied to the top of the shoulder or to the lateral aspect of the hip. The projecting ends of the four rods prevent the rubber bandage

from slipping down the limb, and the meter itself is prevented from sliding by means of tapes passing through the slots in the side flaps. These should be knotted on the upper side of the side flaps (Figure 1). In the case of the shoulder, one tape is secured around the opposite axilla, and another round the arm on the side to be compressed. A pad of wool is required between the anterior and posterior folds of the axilla on the side to be compressed, so that the projecting folds do not shelter the artery from the general pressure. In the case of the hip, one tape is tied around the opposite hip midway between the greater trochanter and the crest of the ilium, and the second tape encircles the top of the thigh. A small pad may be used over the trigonum femorale if there is definite concavity.²

Tumour surgery

Case of myeloma of the radius, extirpation of the lower 3 inches of the radius, bone graft, and recovery

The patient was a lady of 48 years of age who had sprained her wrist 11 months earlier. The sprain subsided, but 4 months after the injury, a swelling had appeared on the lateral half of the dorsal aspect of her left wrist. Since its appearance, the swelling had steadily increased, spreading proximally up the forearm and distally to the bases of the metacarpal bones, and forwards to the ventral aspect of the wrist. On examination, the swelling clearly involved the radius, the surface of which sloped up to the tumour. The consistency of different parts of the tumour varied from very soft to fairly hard. Eggshell crackling was not detected. The skin over the swelling was freely movable. The wrist movements were somewhat limited. The appearances suggested a tumour expanding the lower end of the bone. Such a tumour is usually a myeloma or an endosteal sarcoma. The lower end of the radius is a common site for the development of myeloma. The X-rays gave the characteristic appearance of a myeloma. It was decided to resect the lower part of the radius together with its periosteum and the tumour, keeping well outside its thin capsule. On December 2, 1926, a 6-inch incision was made along the anterolateral border of the wrist and lower part of the radius. The radius was divided with a motor saw at its lower point of trisection, and the dissection carried down from above. Parts of the tendons of the extensores carpi radialis longus et brevis were excised with the tumour, as they had become enveloped in its growth. The prolongation of the growth onto the back of the carpus was especially difficult to excise with a safe margin. A graft was next shaped from the patient's own tibia. One end was pegged with shoulders to fit into the medullary cavity, and the other end was cut much broader with its distal margin oblique. The whole graft was more than half an inch longer than the piece of radius, which was removed. This was done in order to ensure a tight fit and to diminish any subsequent tendency to radial abduction. No-hand-touch and strict-skin-segregation techniques were observed throughout, and the wounds healed without trouble. The forearm and hand were kept in removable plaster for 3 months. The large proportion of giant cells and the large number of nuclei in each are characteristic of a myeloma [author's comment: or rather a giant-cell tumour] as opposed to an endosteal sarcoma (Figure 2). Over 1 year since the operation, there has been no recurrence of the growth and the hand is moderately useful. The graft has survived and functioned with some success.³

Reconstructive surgery

Case of old ununited fracture of the patella with wide separation of fragments, excision of patella, musculo-aponeurotic transplant to close

On December 3, 1937, a Chinese male was admitted with inability to extend his right knee joint following an injury 4 months

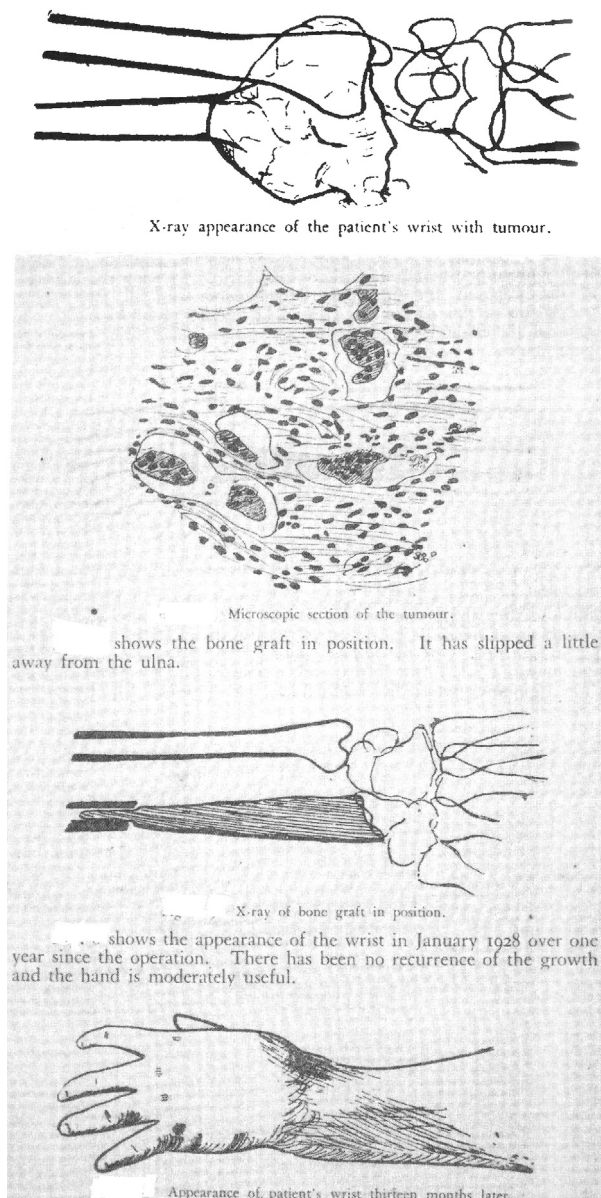


Figure 2. Case of tumour of the distal radius with resection and bone grafting. From Digby [3]. Permission for reproduction has been applied to *The Caduceus: Journal of the Hong Kong University Medical Society*.

previously. At the end of July, the patient slipped and fell on a concrete pavement one rainy day, and was taken home in a rickshaw. The knee was swollen and bruised. On admission, the patient could not extend the right knee joint, and the right thigh was wasted. A fracture of the patella with wide separation of the fragments could easily be palpated. The gap varied from 2 to 3 inches. On January 3, 1938, the fragments were exposed by a curved lateral incision with no hand touch, and strict skin segregation was of course observed. All attempts to bring the fragments together failed. It was decided to excise the fragments. A strip of musculo-tendinous tissue 4 inches long, 1 inch broad, and 1/4 inch thick was excised from the quadriceps. This was turned upside down, and one end was sutured with square stitches to the quadriceps whilst the other end was similarly sewn to the ligamentum patellae. A back plaster was kept until February 18. After the 5th week, the plaster was removed from time to time for active movements. By March 23, flexion beyond a right angle was possible

and the power of extension was good, but the patient was unable to complete the last few degrees of extension.⁴

This case is of interest chiefly because it showed the survival of a large musculo-aponeurotic free transplant. In old neglected case with wide of the fragments of the patella, removal of the fragments widened rather than lessened the gap. But it facilitated the attachment of the transplant. This draws attention to three important functions of the patella:

- (1) It protects the front of the knee joint from direct injury and penetrating wounds.
- (2) It provides a cartilaginous surface diminishing friction over the patellar surface of the femur.
- (3) It gives a better line of pull for the ligamentum patella in the last few degrees of extension.⁵

A past president of the British Orthopaedic Association and the founder of the *British Journal of Surgery*, Ernest Hey Groves (1872–1944) showed a drawing of a specimen of all the fibres of the quadriceps passing over the front of the patella to the ligamentum patellae.⁶ In doubt of this, Digby prepared a specimen from an adult Chinese male cadaver, showing that only a few fibres pass in front, the bulk of the quadriceps being inserted into the front of the upper border, and the bulk of the ligamentum patellae likewise coming from a bony attachment at the front of the lower border of the patella.⁴

Anatomy and surgery of fibrous tissues

In the human body, the tough white fibrous tissue occurs in the form of (1) tendons and aponeuroses; (2) fasciae; (3) ligaments; (4) fibrous linings of compartments; and (5) fibrous membrane layer of the skin and of the mucous membranes.

Tendons

The part of the tendon divorced from its muscle may become a ligament the following instances: original tendon of insertion of pectoralis major becoming the coracohumeral ligament, and original tendon of origin of peroneus longus becoming the fibular collateral ligaments of the knee joint. The tendon is surrounded by loose areolar tissue, which moves to give the tendon free play. This areolar tissue also conveys the blood vessels that supply the tendon with nourishment. When a tendon passes a corner, friction is developed and the friction surface of the tendon becomes lined with synovial membrane, which secretes a lubricating fluid, and the surface of which appears smooth and glistening.

These points with regard to the friction surfaces of tendons and with regard to the significance of tendon sheath ligaments are of the utmost practical importance in dealing with a case of divided tendons. It is clearly of little or no use to suture a divided tendon, if in the process of doing so (1) the smooth friction surfaces of tendon and sheath are permanently damaged opposite to one another so that fixed adhesions and weakening results; and (2) if the sheath ligament is permanently weakened or destroyed especially if the tendon is crossing an internal angle at this spot, one must aim at higher ideals. In the suture of a divided tendon a mere knotting together of the tendon ends with sutures is not always enough to obtain the best possible results. Its repair demands that the sheath shall be opened at one side not onto the shiny anterior surface of the tendon, as this might cause adhesions and the union of the sheath ligament would be weak. The skin and sheath should be raised together if possible to ensure good direct blood supply to the sheath. The cut ends must not be handled. The uniting suture must lie in the centre or substance of the tendon to avoid adhesions. A

special needle on a handle must be passed proximally, and then threaded and withdrawn. The knots must lie on the mesotendon side of the tendon. The proximal one is tied; the end is then passed distalwards along the centre of the tendon, and threaded for pulling along the inside of the distal tendon.⁷

Fascia

The Hong Kong University surgical unit measured the breaking strains of fasciae and aponeuroses. For this, a special tensile thread testing machine was employed. A strip of iliotibial tract 1/8 inch wide in a Chinese adult embalmed corpse broke at 57 lb. In comparison, an extrahard no. 1 catgut suture broke at 4 7/8 lb. The 1/8-inch wide strips of dead iliotibial tract (as is used in Gallie's fascial-suture operation) are stronger than catgut stitches. Professor William Gallie's work at the Medical School at Toronto on fascial sutures has opened a new era in certain branches of surgery.⁸

Gallie demonstrated (1) that autotransplants of deep fascia almost invariably survived as such and continued to live indefinitely; (2) that strips of such fascia used to close gaps under tension were not absorbed like catgut nor replaced by cicatrice tissue; (3) that such strips under tension did not cut through the intervening tissue as did silkworm gut, silk, or other nonabsorbable dead sutures; and (4) that success in the use of fascia to close gaps depended on the firm anchoring in the new bed of the fascia employed to improve upon the cutting of strips of femoral fascia lata.⁹

The Gallie fascial suture has been extensively employed in hernias inguinal, umbilical, cicatricial, or incisional; fractures of patella and olecranon; dislocations; recurrent shoulder dislocation; conoid and trapezoid ligaments; repair of ruptured tendons and ligaments; and congenital ptosis of the eyelid. In some cases, operations have been attempted for spiral fractures of long bones, for some transverse fractures of long bones, for many orthopaedic

deformities, such as some cases of hallux valgus, and neglected cases of congenital talipes equinovarus. Tendons are sometimes employed instead of fascial aponeurosis, one-half of the thickness of the peroneus longus, the plantaris tendon, and the palmaris longus tendon. The university surgical unit has been interested in Gallie's fascial suture since Digby visited Toronto in 1923, employing a conical knot something like that used by a weaver in a cotton mill. When Gallie's needles are not available, a special needle with crocodile jaws for holding fascial strips is also being tried out. It consists of a broad needle with a split shank, which is opened by another needle and is slipped on to the fascia before a strip is raised. The serrations inside the split together with the pressure of the forceps grip prevent the strip from slipping out (Figure 3).

Minor maladies

A minor ailment did not escape Digby's attention.

Ingrowing toenail

This is the result of artificial conditions. It is predisposed to by the wearing of shoes or boots that press upon the medial side of the great toe and crowd the toes together, and of course the condition is commoner in a hot damp atmosphere, such as that of a Hong Kong summer, for the heat causes the feet to swell, and this means that the footwear becomes relatively tight. But, the main exciting cause is cutting the toenails too short. The side of the toenail is rounded and the soft parts can be pressed upon it without causing any difficulties there. The angle between the blunt side and the scissor-cut margin is sharp, and if this angle does not project beyond the soft tissues, the latter may come to be pressed upon it and are liable to be chafed and tender. The irritated soft tissues swell, and as the nail grows distalwards from its base, the sharp angle is driven by the pressure growth into the

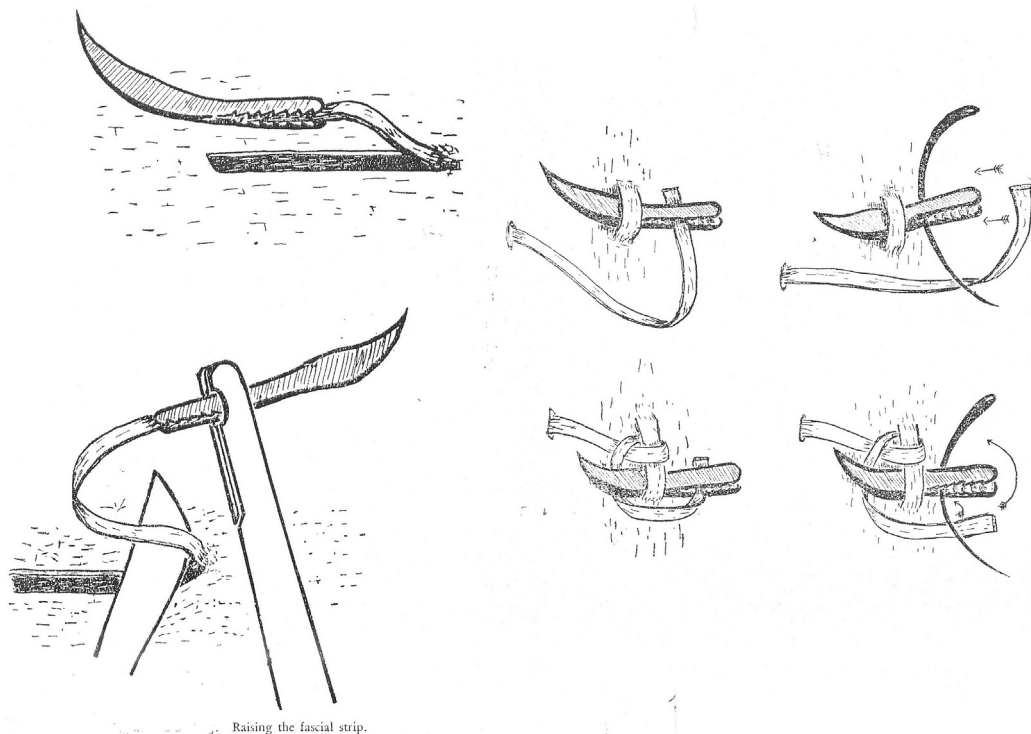


Figure 3. Special surgical needle with crocodile jaws designed by Digby for reconstructive surgery using fascia lata strip. From Digby [7]. Permission for reproduction has been applied to *The Caduceus: Journal of the Hong Kong University Medical Society*.

swollen tissues forced onto it by the shoe. The skin is eventually worn through, and deep septic infection by the border of the nail supervenes. A nail grows in thickness from the whole of its nail bed, but in length from the root, that proximal portion of the nail bed that is covered by skin.¹⁰

The treatment Digby advocated is as follows:

- (1) Prophylactic: The toenails should not be cut short, but left so long that the corners are well clear of the flesh. This is especially desirable in hot climates. As the great toe is the one usually affected, it is with the nail of the great toe that particular care should be taken to avoid it from being cut too short. When the nail has been mistakenly cut too short and tenderness is complained of, but no sepsis has occurred, the aim should be to grow the corner of the nail free of soft tissues as soon as possible. The middle of the free edge of the nail should be cut deeply concave, but the angles not cut at all. These angles should be slightly raised by inserting a strand of soft silk or waxed thread (dental floss is sterile and waxed, and serves well) beneath them (Figure 4). They should be changed every few days. As a rule, they give quick relief. Loose shoes should be worn and exercise on the feet reduced to a minimum until the nails are long enough.

- (2) When infection has occurred, the only course to pursue is avulsion of a part of the nail. A few months later as the nail becomes fully grown, there is danger of recurrence. This can nearly always be prevented by avoidance of shoe pressure, strict abstinence from nail cutting, and raising of the angles on soft silk.
- (3) In the rare cases where there is recurrence of pain and suppuration as the avulsed nail grows, the nail bed (that is, the growing layer of the nail) should be extirpated. After the lateral or medial strip of the nail has been again avulsed, the skin over the root and the tissues along the side border of the nails are raised as a flap. The root is carefully dissected off the sloping proximal part of the terminal phalanx. A very narrow pointed knife is then passed between the rest of the nail bed and the periosteum (Figure 4). It is undesirable in the presence of sepsis to either expose the bone or to open the distal interphalangeal joint, and, on the other hand, complete removal of the nail bed is essential.¹⁰

Education in basic orthopaedic science

In a series of vacation course lectures delivered in 1922, Digby taught the basic science of bone growth in relation to diseases.

Some points concerning the growth of long bones in health and disease

Bone growth always takes place on the surface of a bone. That the interior or substance of bone did not grow was shown long ago by the Scottish surgeon-anatomist John Hunter (1728–1793), who embedded two leaden bullets a couple of inches apart in the tibia of a young pig. When the tibia was fully grown the shot were still exactly 2 inches apart. Hunter also showed by feeding young animals on madder, that bone increased in size by growth of fresh bone on the surface only. The bone formed whilst madder was administered was coloured by the dye. When the animal was killed after some months, he found a broad rim of coloured bone at each end of the diaphysis and a very narrow strip beneath the periosteum. If the administration was stopped some time before the animal's death, the coloured bone was then covered by fresh layers of normal bone-growing cartilage, as well as of young multiplying bone cells.¹¹

Pathology of the vulnerable region

This region is liable to a complete break in continuity resulting in what is known as separation of the epiphysis. Bacteria circulating in the bloodstream may settle at a point of lowered resistance and set up a very serious illness. The two organisms are the *Staphylococcus pyogenes* and the tubercle bacillus, which produces an illness fulminating in its intensity. Pus bursts inwards into the medullary cavity and outwards beneath the periosteum, and rapidly spreads along and kills outright a large part of the bony (acute staphylococcal diaphysitis). The slower and more insidious tubercle bacillus, when it attacks this region, tends to spread to the adjacent joint rather than along the diaphysis. The joint is rarely involved in acute staphylococcal diaphysitis save in the three instances where the vulnerable region of the diaphysis lies well within the joint cavity. Tuberculous disease of the vulnerable region is thus one of the origins of tuberculous arthritis. In neither staphylococcal nor in tuberculous disease is the growing layer seriously affected, so that arrest of growth is rare. It may follow reckless surgical interference, and in acute staphylococcal diaphysitis, very early removal of a

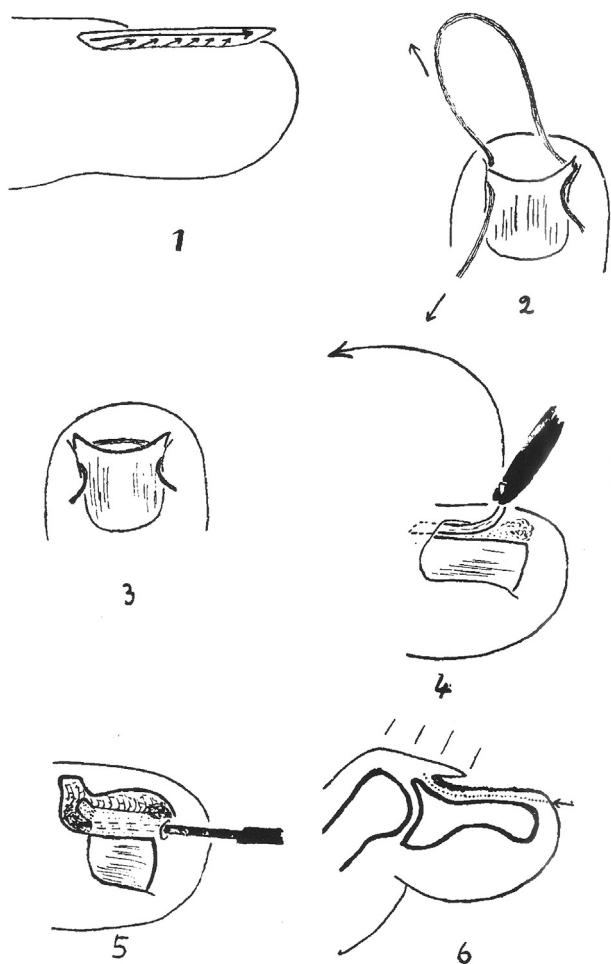


Figure 4. Digby's methods for treating ingrowing toenails. From Digby [10]. Permission for reproduction has been applied to *The Caduceus: Journal of the Hong Kong University Medical Society*.

large sequestrum may be followed by a buckling of the slender involucrum with some resultant shortening.¹¹

Pathology of the growing layer

Rickets, which produces its effects in the growing layer, leads to the deposit of a layer of incomplete consolidation that is soft. The soft bone yields to pressures and strains producing the bulging at the ends of the bones and the characteristic deformities. The soft bone is more than usually liable to fracture, and the fracture produced is often characteristic and known as a greenstick fracture.¹¹

Cancellous exostoses

There has been some arrest of growth of patches of the growing layer. There may even be some general arrest for the patients that tend to be stunted in their growth. Unequal rates of growth alter the plane of parts of the growing layer, which now no longer grow in the long axis of the bone, but project sometimes at an acute, sometimes at an obtuse, angle with the shaft. The summit of the exostosis is covered by a layer of cartilage beneath which is the growing layer. In excising these surgically, the whole of the cartilage and adjacent area, that is the growing layer, must be removed if recurrence is to be avoided.¹¹

The periosteum covering the epiphyseal part of the bone and to some extent the adjacent diaphyseal part of the bone is especially vascular and sends in very large vessels. The foramina for these vessels are a very noticeable feature of the ends of the long bones. These vessels not only supply the articular ends of the bones, but also and principally the red marrow in the cancellous tissue. The capsular ligament is attached to the epiphysis. In a few cases, the redundant capsular ligament and synovial membrane overlap onto and secure a secondary attachment to the diaphysis. This is the case with the neck of the femur, the proximal end of the radius, the distal and proximal ends of the humerus, and the distal end of the femur. The reflected part of the capsule partly remains as bands on the surface of the bone called retinacula. In these three cases, the growing layer of the diaphysis and the adjacent vulnerable region lie entirely or almost entirely within the joint cavity, an important matter in acute diaphysitis.¹¹

Amputations in children

When a child's limb has to be amputated, the fact that the bone grows more from one end than from the other has to be taken into consideration. Where more growth takes place from the proximal end, the bone should be cut shorter than usual; where more growth takes place from the distal end, the bone may be left a little longer than usual. A knowledge of the amount of growth at the proximal end of the diaphysis enables one to determine by a formula the approximate amount of bone requiring removal when an amputation through the arm in a child.¹¹

Conflicts of interest

The author has no conflicts of interest to declare.

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